Beverage Tests

Concepts

- Become familiar with the pH scale
- Determine the pH of a liquid
- Create graphs comparing pH levels
- Compare the same data displayed as a scatterplot, a boxplot, a histogram, and a bar graph

Materials

- TI-84 Plus
- Vernier® EasyLink™ & pH probe
- Vernier® EasyData™ Application
- Distilled water for rinsing sensor
- Beaker or container for rinse water
- Beverage samples

Overview

In this activity, you will pour samples of common beverages/liquids into sample cups, and use the EasyLink™ with a pH sensor and the EasyData™ APP to test their pH levels. Then you will choose a graph that will compare the liquids by their pH readings.

Introduction

Scientists use a pH scale to measure the acidity or alkalinity of various solutions such as swimming pool water, lakes and rivers, and even our blood. This lesson is an entry level lesson to help students get more of an understanding of this scale. The pH scale is a measure from 0 to 14. A pH lower than 7 is an acid solution, and a pH greater than 7 is basic or alkaline. A pH of 7 is considered neutral.

In this activity, you will pour samples of common beverages/liquids into sample cups, and use the EasyLink™ with a pH sensor and the EasyData™ APP to test their pH levels. Then you will choose a graph that will compare the liquids by their pH readings.

Problem: Are most of the beverages you drink each day acids, neutral, or bases?

Hypothesis: Before testing, have students answer questions 1 and 2 on their worksheet to predict the pH of some common beverages. Have students fill in the chart with the items you decide to use.

Setup

1. Briefly discuss the data collection procedure with the class. Demo the activity using the overhead calculator so the entire class can see the process. If you only have one EasyLink™ and pH sensor, link the data lists to the class after running the activity.
2. If you have enough equipment, have the students work in small groups. Use small plastic or waxed paper cups for the beverage samples. Provide a variety of popular beverages to test. Suggestions for liquids to test are tap water, milk, orange juice, lemonade, tea, soda, and coffee.
3. As a hypothesis, students can rank beverages from least to greatest by acidity or they could predict acid, neutral, or base for each sample. They could also predict both. It is a good idea to have at least one sample of something you would not drink. In the example, the last sample is ammonia.

CAUTION: Be sure to consider that some students may be allergic to some beverages.

4. Provide at least 125 ml of distilled water for rinsing the pH sensor between trials. Crook-necked bottles work well. Be sure all containers are very clean.
5. Each group should have its own water for rinsing between samples. Since the order the readings are taken is not important, have a few clearly marked samples of each liquid in one area of the room.
6. Students can carry one or two samples at a time from that area to the area where their group is working. After taking those readings, the samples can be returned.

Suggest these student jobs for this lab:

1. Materials/setup person (sets up EasyLink™, pH sensor, and TI-84 Plus: holds probe in sample during activity, rinses probe in water between samples)
2. Tech person (operates EasyData™ APP and TI-84 Plus)
3. Data recorder (reads and records the pH readings for each sample on the worksheet chart).

4. Runner (brings samples to group, holds cup to avoid spillage during activity, and returns samples after readings are taken)

NOTE: The pH sensor must remain in buffer solution bottle (packaged with the sensor) when not in use. The sensor will stop working if it becomes completely dry.

DATA COLLECTION

1. Connect the EasyLink™ to your TI-84 Plus using the mini-USB port.
2. Connect the pH sensor to the other end of the EasyLink™.
3. The EasyData™ APP will launch automatically.
   - The EasyData™ information screen is displayed for about 3 seconds followed by the main screen.
   - The APP identifies the pH sensor.
   - The main screen of EasyData™ is shown in Figure 1.
4. Press [Y=] to access the **File** menu, and select **1:New** by pressing [1] or, since **1:New** is highlighted, you can press [ENTER].
   - This resets the program and clears out old data (Figure 2).
5. Press **Setup**, and choose **4:Selected Events**.
   - This setting will allow you to control when readings are taken (Figure 3).
6. Unscrew the cap from the pH sensor's storage bottle. Slide the cap up the probe so it is out of the way but do NOT remove it from the probe's shaft.
   - Rinse the probe in the distilled water. Select Start to begin collecting data.
   - You will see the current pH in the upper right corner of the screen.
   - Let the water be your first reading.
   - Wait for the pH reading to be stable, and then select **Keep** to take the reading. Be sure to record it on your worksheet (Figure 4).

Figure 1

Figure 2

Figure 3

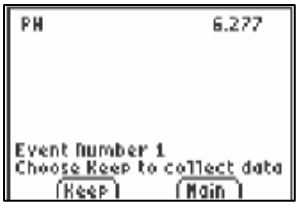

Figure 4

7. Insert the probe into the second sample, and wait for the reading to become stable.
   - Select **Keep** to collect the pH reading.
   - Continue for a total of 8 trials (or the number of samples you have).
   - With each recorded value, a new data point will be displayed on the graph with the option to **Keep** or **Stop** the data collection.
   - The **Selected Events** feature will keep track of which reading you are on, increasing it by one each time you select **Keep** (Figure 5).

   NOTE: After each reading, the pH sensor should be rinsed in the distilled water before being used for the next reading. The recorder should be filling in the chart on the worksheet with each beverage and its pH reading.

Figure 5

8. When all samples have been measured, select **Stop**.
   - A graph of your data points will be displayed.
   - At this time, you can use the right and left arrow keys to view the values of the coordinates of the points.
   - Have students double-check these values with what was recorded in the chart (Figure 6).

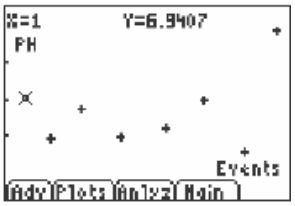

Figure 6

9. To confirm a description of the plots, select the **Plots** soft key.
   - You should see a confirmation that the points graphed are the pH values vs. the Events number.
   - Be sure your students identify the Events number as the independent variable and the pH reading as the dependent variable (Figure 7).

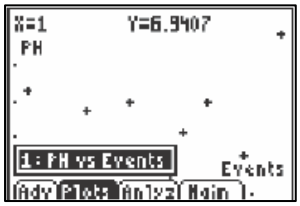

Figure 7

10. Select **Main**, and then select **Quit**.
    - A screen displays where the data from your activity is being stored.
    - Select **OK** to exit the **APP** (Figure 8).

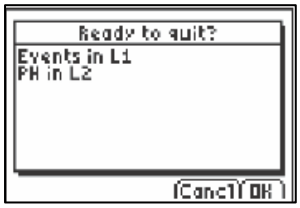

Figure 8

DATA ANALYSIS

1. Press [2nd] [Y=] to access the [STAT PLOT] menu; you will see that **Plot1** is turned on with the **L1** and **L2** data (Figure 9).

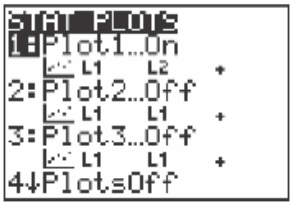

Figure 9

2. Press GRAPH, and you will see the same graph that was displayed right before you left the APP.
   - At this point, have students link the data lists so each student has **L1** and **L2** from the activity in his/her own calculator for the Data Analysis (Figure 10).
3. Have each student set up the same scatterplot on **Plot1** to display the pH data.
   - Go to the Y= window, and graph a horizontal line at 7 (Figure 11).
   - Press ZOOM, and choose **9:ZoomStat** to view the graph.
   - Have students sketch the scatterplot in the space provided on their worksheet.
   - Discuss the meaning of the location of the points relative to the horizontal line at pH = 7 (Figure 12).
4. Have students trace through the points, and discuss the meaning of the fact that most points are below the line Y = 7.
   - Discuss the meaning of any points that are significantly different from the others (Figure 12).
5. Guide students in viewing the data as a box-and-whisker plot.
   - First, go to the Y= window and clear **Y1**.
   - Go back to **Plot 1**, select the box-and-whisker icon, enter **L2** for the **Xlist**, and 1 for **Freq:** (Figure 13).
   - Press ZOOM, and choose **9:ZoomStat** to view the new graph.
   - Have students sketch the box-and-whisker plot in the space provided on their worksheet.
   - Have them trace the plot and move from one part of the plot to another, paying attention to the data at the bottom of the screen.
   - Have students place the screen data in the appropriate place on the plot they are sketching on the worksheet.
   - See Figures 14-18.

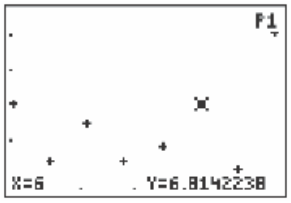

Figure 10

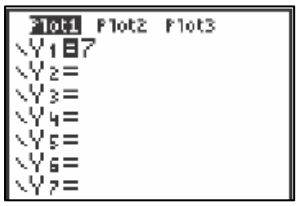

Figure 11

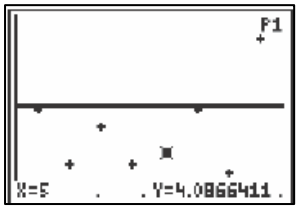

Figure 12

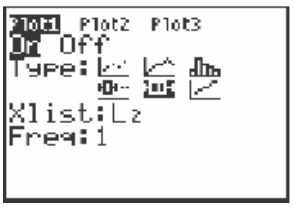

Figure 13

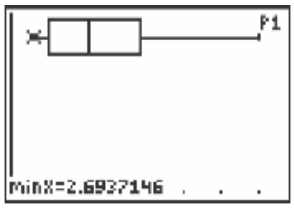

Figure 14

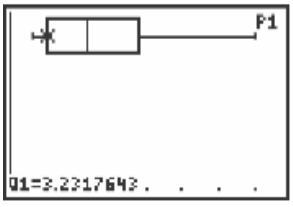

Figure 15

6. Lead your students in a discussion about observations that are easily made based on the length of both the whiskers and the boxes.

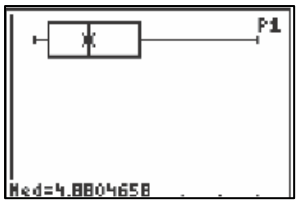

Figure 16

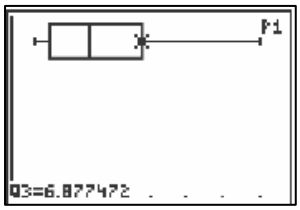

Figure 17

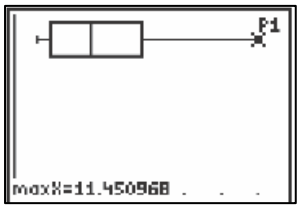

Figure 18

EXPLORATION

1. Guide students in presenting the data in a histogram.
   - Adjust the **Plot1** setting to select a histogram rather than the boxplot just used (Figure 19).
   - Then press [ZOOM], and choose **9:ZoomStat** to view the new graph (Figure 20).
2. Press the right and left arrow keys to scroll through the bars. Discuss which graph they think gives more information about the data.
   - Trace the data and make sure they see that the n at the bottom of the window is the number of items in the bar marked by the cursor.
   - In the example here, 4 of the 8 data collected were between 2.69 and 4.88 (Figure 20).
   - Encourage students to adjust the window settings that will allow the graph to display the data in a more useful way.
3. Before leaving this problem, show students how to display data to look like a bar graph by making a few adjustments to the histogram feature.
   - In the [STAT PLOT] menu, go into **Plot1** and adjust the settings from above by entering **L1** for the **XList** and **L2** for the Freq (Figure 21).

Figure 19

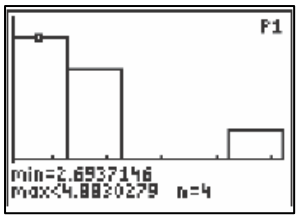

Figure 20

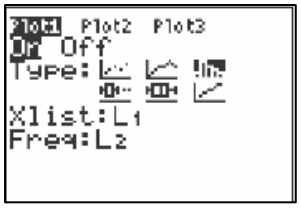

Figure 21

4. Press [WINDOW], and select appropriate settings. In the sample, 8 items were measured.
   - By setting the **Xs** from 1 to 9 with a scale of one, there will be 8 bars generated, one for each item.
   - The pH readings can only go from 0–14. In the sample, the highest reading was 11.45.
   - The **Ymax** needs to be at least that high.
   - The -3 for the **Ymin** will give space below the graph
   - (Figure 22).
   - When the graph is traced, the numbers can be viewed without blocking part of the graph (Figure 23).
5. Press [GRAPH], and then [TRACE] to see that each bar represents one sample with the pH value being displayed beside the n at the bottom of the window (Figure 23).
6. Pressing [GRAPH] again erases the data displayed at the bottom of the screen.
   - The goal now will be to label this graph, and save it as a picture in the calculator (Figure 24).
7. Press [2nd] [PRGM] to access the [DRAW] menu, and arrow down until **0:Text(** is highlighted.
   - Press [ENTER], and youou will be taken to the graph screen.
   - Remember, most menus are wrap-around menus, so you could also press the up arrow key twice to get to **0:Text(** (Figure 25).
8. Your cursor is most likely near the center of the screen. Do NOT press [TRACE].
   - Use the arrow keys to position the cursor to the upper left corner of the screen, and then press [2nd] [ALPHA] to access the ñ command.
   - This will lock the calculator in Alpha mode so you can continuously type text across the screen.
   - Notice the **A** in the upper right corner (Figure 26).
9. When you begin to type, you will notice that the text falls below and to the right of where the cursor is positioned.
   - Give the graph a title. This example is titled, "PH VS COMMON LIQUIDS."

Figure 22

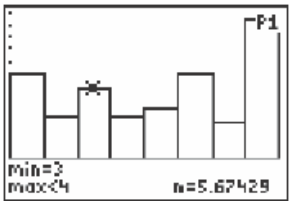

Figure 23

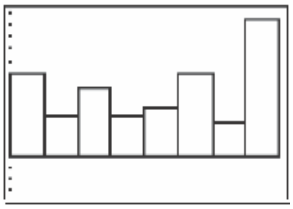

Figure 24

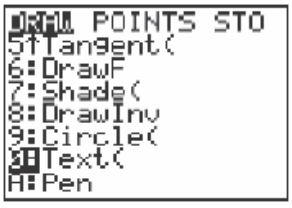

Figure 25

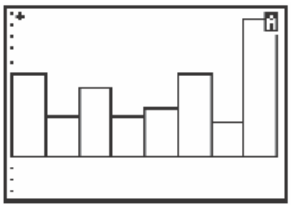

Figure 26

- Only uppercase letters can be used. For spaces, use _ (above the zero key).
- If you make a mistake and need to erase something, arrow back to the left of what you need to erase and press the zero key again.
- Anything you type will overwrite anything that is written below it.
- To erase things, type blank spaces over the error (Figure 27).

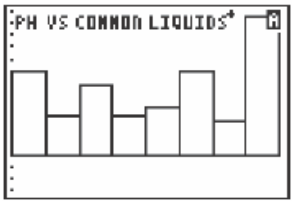

Figure 27

10. After the title is complete, use the arrow keys again to position the cursor below the first bar.

- You don't have much space, so use the first one or two letters as descriptors for the individual bars as demonstrated in the example, e.g., W for Water, V for Vinegar (Figure 28).

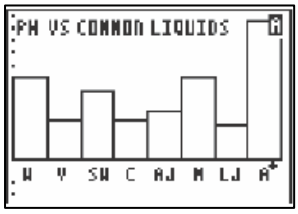

Figure 28

11. When finished, press 2nd MODE to [QUIT], and return to the home screen.

- You are going to store this picture in the calculator.
- There are 10 locations in which to save a picture.
- If there is already something in the location you choose, it will be overwritten with no warning.
- It is a good idea to first take a look at where pictures are stored.

12. Press 2nd + to access the [MEM] menu.

- Select **2:Mem Mgmt/Del**, and press ENTER.
- Scroll down until **8:Pic** is highlighted, and press ENTER (Figure 29).

Figure 29

- You will see a list of locations that are already filled with pictures. If you do not see any **Pics** listed, then there are no pictures stored in your calculator.
- The example shown here indicates that **Pics** 1, 4, 5, 6, and 7 are all available.
- The * in front of **Pic9** means it is archived (Figure 30).

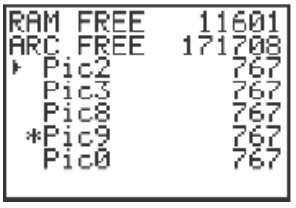

Figure 30

13. Press 2nd MODE to [QUIT] and return to the home screen.

- Press 2nd PRGM to access the [DRAW] menu, and arrow over to **STO**.
- **1:StorePic** is highlighted (Figure 31).

Figure 31

14. Press [ENTER] to select it, and then type the number of the **Pic** where you want to store your picture.
    - In the sample it will be stored in **Pic1** (Figure 32).
15. Pressing [ENTER] again will complete the command and return you to the graph screen.
    - You could now delete all your data in the lists and/or turn off **Plot1**, and this picture would remain intact.
    - However, it is a stagnant picture. You will no longer be able to adjust the size of the window or trace the graph to view the coordinates (Figure 33)

    NOTE: When you make a change to anything in the [Y=] or the [STAT PLOT]window, the drawing will be cleared from the display. To view it again, press [2nd] [PRGM] to access the [DRAW] menu, and arrow over to **STO**. Select **2:RecallPic** followed by the number of the picture that was stored.
16. After saving the picture, have students see if they can add to the drawing by putting in the pH values at the top of each bar.
    - The process is the same as for adding letters to a drawing, but do not put the ñ on to type numbers (Figure 34).
17. After adding the numbers, store the picture either in the same location as before or in a new location.
    - Caution them to remember to press [2nd] [MODE] to [QUIT], and return to the home screen before trying to store the picture.
    - If they forget that step, they could end up with the **StorePic** command in the middle of their picture as shown here.
    - Unfortunately there is no "undo" command for this error (Figure 35).

Figure 32

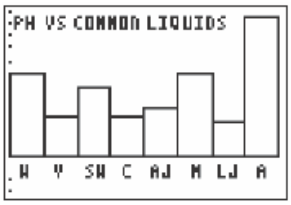

Figure 33

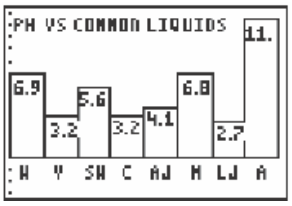

Figure 34

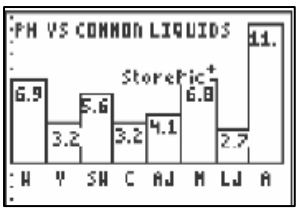

Figure 35

WORKSHEET ANSWERS

You can use any beverages/liquids you choose. Here is an example.

Sample Number	Beverages	Actual pH	Actual pH description (acid, neutral, or base)	Rank (1= most acidic)
1	Water	6.94	Neutral	7
2	Vinegar	3.2	Acid	2
3	Salt water	5.67	Acid	6
4	Soda	3.26	Acid	3
5	Apple Juice	4.09	Acid	4
6	Milk	6.81	Neutral	6
7	Lemon Juice	2.69	Acid	1
8	Ammonia	11.45	Base	8

Other answers are either addressed in the directions, or will vary depending upon the data collected.

Beverage Tests

Student Worksheet

Name _____

Class _____

Math Concepts

- Become familiar with the pH scale
- Determine the pH of a liquid
- Create graphs comparing pH levels
- Compare the same data displayed as a scatterplot, a boxplot, a histogram, and a bar graph

1. Are most of the beverages you drink each day acids, neutral, or bases?

2. Before testing, complete the table below.

- Write *acid*, *neutral*, or *base* to categorize each beverage.
- Use your current knowledge of pH to predict the rank of each in order of pH (1 = most acidic = lowest pH value).

Beverages	Predicted pH description (acid, neutral, or base)	Rank (1 = most acidic)

3. After you test the beverages, use the displayed scatterplot to fill in the pH values on the table below.

- Then, label each beverage as an acid, a neutral, or a base and rank them in order of pH (1 = most acidic). (Round all numbers to the nearest hundredth.)

Sample Number	Beverages	Actual pH	Actual pH description (acid, neutral, or base)	Rank (1 = most acidic)
1				
2				
3				
4				
5				
6				
7				
8				

4. Set up a scatter plot on **Plot1** to display the pH data.

- Go to the Y= window and graph a horizontal line at 7.
- Press GRAPH, and print it out on a computer and attach it to this page, or sketch it in Figure 1.

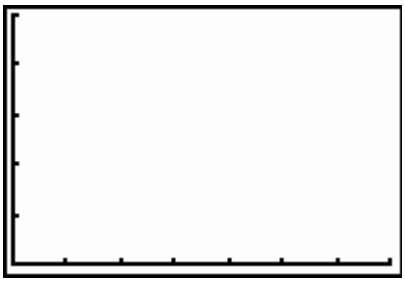

Figure 1

- Discuss the meaning of the location of the points relative to the horizontal line at pH = 7.

5. Go to the [Y=] window, and clear the Y= line.

- Draw a boxplot to display the pH data, and print it out on a computer and attach it to this page, or sketch it in Figure 2.

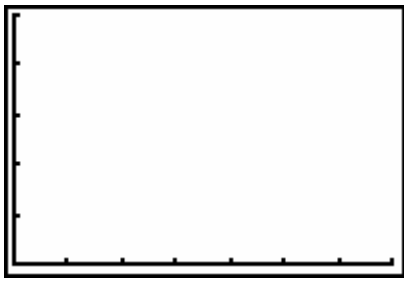

Figure 2

Use your data and graphs to answer the following questions.

6. Compare the actual pH rankings to your predictions. Discuss any surprises or differences you find.

7. Match each description to a tested beverage.

- Most Acidic _____
- Most Basic _____
- Closest to neutral _____
- Median beverage _____

8. What is the range in the pH readings?

9. Find the mean pH.

10. Find the median pH.

11. How does the mean compare to the median?

12. Which measure would best describe the average beverage?

13. Where do most of the beverages cluster on the graph?

14. What does this reveal about most of the beverages you drink?

Exploration

1. Set up a histogram in Plot1 to display the pH data with the settings as shown in Figure 3.

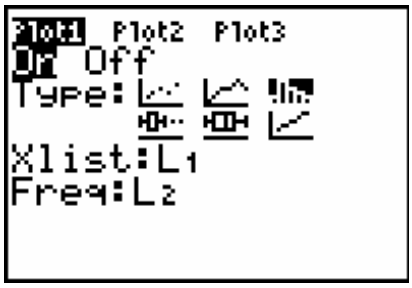

Figure 3

- Follow your teacher's directions to adjust the window settings so the histogram will display a bar graph where each bar represents one of the liquids measured (Figure 4).

Figure 4

- Record your window settings here.

2. Press GRAPH, and use TI Connect™ to take a screen shot, print it out on a computer and attach it to this page. Or sketch it in Figure 3.

Figure 4

3. Follow your teacher's directions to label your graph, and save it as a picture.

- Add these labels to the sketch here.

4. What is/are the advantage(s) of being able to write on the graph and save it as a picture?

5. What is/are the disadvantage(s) of saving the graph as a picture?

